Groundstate properties of the unbound $T_z = 5/2$ nucleus ^{15}Ne *

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In this report we present our findings on the properties of the recently observed ^{15}Ne [1], with a focus on its ground-state structure and the decay mechanism to ^{13}O.

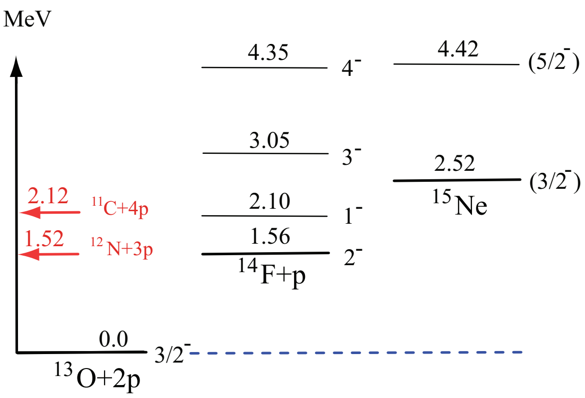

Fig. 1: Level scheme of ^{15}Ne and neighbours along its decay path to ^{13}O [2]. Decay via ^{14}F is energetically possible.

Fig. 1 shows a level scheme of the unbound ^{15}Ne, the also unbound ^{14}F, and the finally bound ^{13}O [2]. In order to cast light on the decay mechanism of the ground state of ^{15}Ne – be it a *diproton*, a *three-body*, or a *sequential* decay via a state in the unbound ^{14}F – we studied its 3-body energy correlations and compared them to those in ^{16}Ne, which is known to decay in a *three-body* way [3, 4, 5].

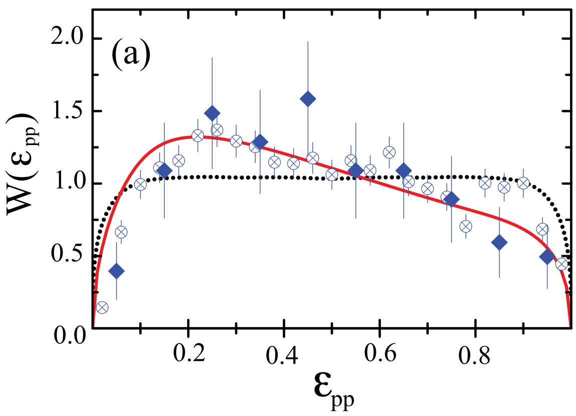

Fig. 2: Fractional relative energy (E_{pp}/E_{fpp}) distributions in the ground states of ^{15,16}Ne [2, 5]. See text for details.

Fig. 2 shows the (E_{pp}/E_{fpp}) fractional relative energy of the ground states of ^{15}Ne (filled diamonds), of ^{16}Ne (open diamonds) and a *three-body* decay calculation for ^{16}Ne [5] (full red line), and a calculation for *sequential* decay of ^{15}Ne via the ^{14}F ground state (black dashed line). The striking similarity to the pattern for ^{16}Ne, combined with the discrepancy to the *sequential*-decay shape, leads us to conclude that, like in ^{16}Ne, also the ^{15}Ne ground state undergoes *three-body* decay.

Furthermore, we used the measured two-proton separation energy of ^{15}Ne of 2.522(66) MeV, translated into an atomic mass excess of 40.215(69) MeV, to deduce the $(1s_{1/2})^2$ occupation probability of its unbound valence-proton pair in the ground state. We followed the approach of Fortune [6] shown in Fig. 3, using a correlation between the $(1s_{1/2})^2$ value for valence-nucleon pairs in $Z = 8, 10$ mirror nuclei and their 2n-2p separation-energy difference in order to predict the ^{15}Ne ground-state energy. Using our measured value of S_{2p} = 2.522(66) MeV, we have turned the relation around to predict an $(1s_{1/2})^2$ content for the ^{15}Ne ground state of 63(5) $\%$ (red square in Fig. 3).

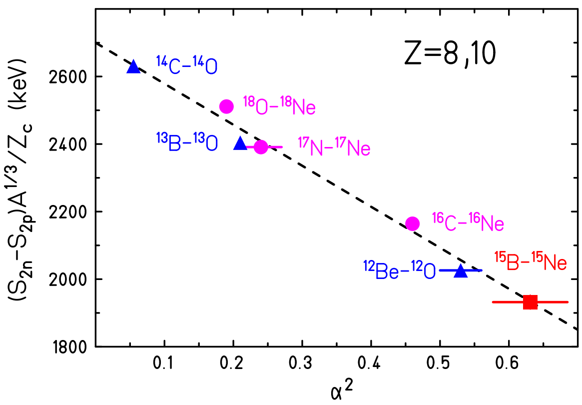

Fig. 3: Relation of ΔS_{2N} to $P((1s_{1/2})^2)$ in $Z = 8, 10$ mirror-nucleus pairs (based on [6]). See text for details.

References

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